

## Accelerator Safety Envelope

**Title of Facility:** Relativistic Heavy Ion Collider

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**Signature of Deputy Director for Operations:**

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## Section 1. Introduction

The ASE Requirements define the conditions, safe boundaries, and the administrative controls necessary to ensure safe Collider operations and to reduce the potential risk to the public, workers and environment.

- 1.1 The reference to the method used by the Collider-Accelerator Department for change control of the ASE is the BNL Subject Area on [Accelerator Safety](#).
- 1.2 A variation beyond the boundaries described in Sections 1, 2, 3, and 4 of this ASE shall be treated as a violation of the ASE and shall be a reportable occurrence, as defined by the BNL [SBMS](#) Subject Area on Occurrence Reporting. A violation is defined as not satisfying a Requirement or its specific Authorized Alternative. C-A Department staff shall make notifications of occurrences according to the requirements in the [C-A Operations Procedure Manual](#).
  - 1.2.1 If a Requirement is not satisfied and it has a specific Authorized Alternative, **either** implement the Authorized Alternate or stop the activity that uses the affected equipment within one hour.
- 1.3 Emergency actions may be taken that depart from these approved ASE Requirements when no actions consistent with the Requirements are immediately apparent and when these actions are needed to protect the public, worker and environmental safety. These actions shall be approved by the person in charge of facility safety, as defined in the operating procedures, when the emergency occurs and shall be reported to C-AD management within 2-hours.

## Section 2: BNL Safety Envelope Limits

This section contains the absolute limits that BNL places on its operations to ensure that we meet the regulatory limits established to protect our environment, public and staff/visitors and that those operations are conducted within the assumptions of the RHIC Safety Analyses documented in the [C-AD SAD, August 2004](#). BNL Safety Envelope Limits for Collider operations are:

- 2.1. Less than 25 mrem in one year to individuals in other BNL Departments or Divisions adjacent to a Collider-Accelerator Department accelerator facility.
- 2.2. Less than 5 mrem in one year to a person located at the site boundary.

- 2.3. Offsite drinking water concentration and on-site potable well water concentration must not result in 4 mrem or greater to an individual in one year.
- 2.4. Less than 1250 mrem in one year to a Collider-Accelerator Department staff member.
- 2.5. Maximum tritium concentration of 10,000 pCi/L in the BNL sanitary sewer effluent, caused by liquid discharges from Collider facilities averaged over a 30-day interval.
- 2.6. In order to protect groundwater, if the annual activity concentration of sodium-22 or tritium in leachate is calculated to exceed 5% of the Drinking Water Standard, then a cap shall be used unless BNL Management is convinced otherwise.<sup>1</sup>
- 2.7. All emissions from Collider facilities are managed in accordance with the Air Emissions subject area.<sup>2</sup> If emissions are anticipated to exceed 0.1 mrem per year to the Maximally Exposed Individual, actions will be taken to ensure operations comply with NESHAP requirements including continuous emissions monitoring and permitting.

### Section 3: Corresponding Collider Safety Envelope Parameters

This section identifies the measurable limitations on critical operating parameters that, in conjunction with the specifically identified hazard control considerations established by the facility design and construction, ensure that Collider operations will not exceed the corresponding Collider Safety Envelope Limits discussed in Section 2. These parameters are derived from the safety analyses described in the [C-AD SAD, August 2004](#). Collider Safety Envelope Parameters are:

#### Collider Particle Limit and Limits on Particle Loss

- 3.1. The maximum number of heavy ions in each ring shall not exceed the equivalent of  $2.4 \times 10^{11}$  Au ions at 100 GeV/u.
- 3.2. The maximum number of protons in each ring shall not exceed the equivalent of  $2.4 \times 10^{13}$  at 250 GeV.

#### Control of Beam Loss

- 3.3. Loss monitoring results and radiation survey results shall be used in order to maintain beam loss "As Low As Reasonably Achievable" as defined in the [BNL Radiological Control Manual](#).

<sup>1</sup> BNL SBMS Accelerator Safety Subject Area, [Design Practice for Known Beam Loss Locations](#).

<sup>2</sup> BNL SBMS Subject Area, [Radioactive Airborne Emissions](#).

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- 3.4 Beam loss induced radiation within uncontrolled areas is less than 0.5 mrem in an hour and for repeated losses less than 25 mrem in a year.
- 3.5 Beam loss induced radiation in a Controlled Area is less than 5 mrem in an hour and for repeated losses less than 100 mrem in a year.

### Classification of Radiological Areas

- 3.6 Radiological area classifications shall be in accord with requirements in the [BNL Radiation Control Manual](#).

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### Particle Accelerator Safety System (PASS)

- 3.7 The Access Controls System shall be functional during operations with beam.
- 3.8 During the running period, area radiation monitors that are interfaced with the Access Controls System shall be within their calibration date.
- 3.9 High intensity proton beam is to be prevented from the W line either by the Access Controls System or by lock out / tag out of appropriate critical devices.
- 3.10 During the running period, the locations of area radiation monitors interfaced with PASS are to be configuration controlled.

### Oxygen Deficiency Hazard (ODH) Control

- 3.11 ODH area classification and controls shall in accord with the requirements in the BNL SBMS Subject Area, [ODH Classification / Controls](#).

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### Fire Protection

- 3.12 During periods of beam operation, when access to the Collider primary beam areas is prohibited, the installed fire detection ~~system~~ shall be operable ~~as follows~~:

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~~3.12.1 Both smoke detector strings in an area shall be fully operational. Note: The collider has two 'strings' of smoke detection in a cross-zoned arrangement for redundancy. An area is covered by an 'A' string detector, then a 'B' string detector as you walk along the tunnel.~~

**Deleted: Authorized Alternative:**  
Within 2 hours of discovery, the Department Chair or designee may allow partial or full inoperability of any fire detection and/or suppression system for up to 80 hours with beam operations if the benefit of continuing Collider operations is judged to outweigh the potential risk of fire damage. Operating procedures shall specify the compensatory actions to be taken during inoperability.

#### ~~Authorized Alternatives:~~

- ~~1) Up to two smoke detectors per string in an area may be inoperable with approval of the BNL Fire Protection (FP) Engineer. Required compensatory actions shall be specified by the FP Engineer to ensure equipment protection. These compensatory actions shall be implemented by the MCR Operations Coordinator.~~
- ~~2) One smoke detector string in an area may be inoperable if the heat detector string in the affected area is operable. The inoperable smoke detector string shall be~~

**Deleted:** 3.13 During periods of shutdown, and if the facility is to be occupied, either the installed fire detection and suppression systems or the manual fire alarm stations in the occupied areas shall be operable.

made operable on the next maintenance day, not to exceed 10 days from discovery.

- 3) Both smoke detector strings in an area may be inoperable if the heat detector string in the affected area is operable. Both smoke detector strings shall be made operable on the next maintenance day, not to exceed 4 days from discovery.
- 4) If both smoke detector strings and the heat detector string in an area are out of service, shutdown the facility within 8 hours of discovery.

3.13 During periods of shutdown, and if the primary beam area is to be occupied, at least one of the smoke detector strings in the occupied area OR the heat detector string AND the fire alarm bells shall be operable.

Authorized Alternative: The Operations Coordinator, ESH Coordinator or designee may allow partial or full inoperability of any fire detection system or fire alarm bell in occupied areas as long as a Fire Watch is posted who can verbally communicate to evacuate occupants and to contact the BNL Fire/Rescue Group by radio or phone.

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- 3.14 Personnel may occupy the tunnel if the exhaust fans in the area occupied, required for personnel protection during an emergency, can be manually activated.

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Authorized Alternative: If exhaust fan manual operability in the affected area cannot be restored within four hours, then empty the affected area of occupants and prevent occupancy until operability is restored.

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## STAR Experiment

- 3.15 The following are required whenever flammable gas is in the integrated detector positioned in the intersecting region (IR):

- 3.15.1 Both STAR and PASS flammable gas detection systems shall be operational.

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Authorized Alternative: Within 2 hours of discovery and if requested by the Experimental Shift Leader, the Department Chair or designee may allow partial or full inoperability of any one of the two flammable gas detection systems for up to 8 hours with flammable gas present if the benefit of continuing STAR detector operations is judged to outweigh the potential risk of STAR experiment damage. Operating procedures shall specify the compensatory actions to be taken during inoperability.

- 3.15.2 If the Silicon Vertex Tracker, SVT, or the Silicon Strip Detector, SSD are operational, then the Inner Field Cage, IFC, detector ventilation system shall be delivering air flow.

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Authorized Alternative: Beam operations with flammable gas may continue for up to 8 hours. Operating procedures shall specify the compensatory actions to be taken during inoperability.

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- 3.15.3 At least one of the two emergency exhaust fans that are connected to PASS shall be operable.
- 3.15.4 A quantity of purge gas shall be maintained to dilute the detector flammable gas volumes below 25% of the Lower Explosive Limit.
- 3.15.5 Purge gas operational requirements shall be defined in approved STAR Operating Procedures for the detector.
- 3.15.6 The TPC gas used in the detector shall be P-10 or equivalent hazard. The Collider-Accelerator Department shall approve equivalent hazardous gases prior to use.
- 3.15.7 When the TPC is in operation, no more than 80 cubic meters of methane gas at STP shall be attached to the gas mixing system.
- 3.15.8 When electronics are powered in the integrated detector in or out of the IR the Highly Sensitive Smoke Detection (HSSD) system on the detector or the ceiling-level HSSD system shall be operational.

### PHENIX Experiment

- 3.16 The following are required whenever flammable gas is in the integrated detector positioned in the intersecting region (IR):

- 3.16.1 Both PHENIX and PASS flammable gas detection systems shall be operational.

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Authorized Alternative: Within 2 hours of discovery and if requested by the Experiment Shift Leader, the Department Chair or designee may allow partial or full inoperability of any one of the two flammable gas detection systems for up to 8 hours with flammable gas present if the benefit of continuing PHENIX detector operations is judged to outweigh the potential risk of PHENIX experiment damage. Operating procedures shall specify the compensatory actions to be taken during inoperability.

- 3.16.2 Both emergency fans, EF1 (exhaust) and EF2 (supply) that are connected to PASS shall be operable.

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- 3.16.3 A quantity of purge gas shall be available to dilute the detector flammable gas volumes below 25% of the Lower Explosive Limit.

3.16.4 Purge gas operational requirements shall be defined in the approved PHENIX Operating Procedures for the detector.

3.16.5 ~~The~~ detector ~~or~~ ceiling level HSSD systems shall be operational.

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3.16.6 The PHENIX High Capacity Ventilation System shall be operational before introduction of flammable gas into the Ring Imaging Cerenkov Counter, RICH.

**Deleted:** Authorized Alternative: If requested by the Experiment Shift Leader, the Operations Coordinator, ESH Coordinator or designee may allow partial or full inoperability of both HSSD systems as long as a Fire Watch is posted who can verbally communicate with the BNL Fire/Rescue Group by radio or phone. ¶

3.16.7 The interstitial space between the RICH and the Pad Chamber FEE shall be inerted when introduction of flammable gas is in the RICH.

3.17 Whenever electronics are powered in the integrated detector in or out of the IR:

3.17.1 The electronics racks interlocks in the IR shall be operational.

Authorized Alternative: Within four hours of discovery, de-energize the integrated detector electronics.

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3.17.2 Either the Highly Sensitive Smoke Detection (HSSD) system on the detector or the ceiling-level HSSD system shall be operational.

3.18 If the IR is occupied by personnel after flammable gas is present, then both the personnel plug door and the emergency escape labyrinth shall be available for egress.

### Experiments In General

3.19 During shutdown periods when MCR is not staffed, specific safety requirements for the experiments shall be reviewed on a case-by-case basis by the C-AD Experimental Safety Review Committee and approved by the C-AD Department Chair.

## Section 4: Engineered Safety Systems Requiring Calibration, Testing, Maintenance, and Inspection

The systems and requirements for calibration, testing, maintenance, accuracy or inspection necessary to ensure the operational integrity of the Collider Safety Envelope Parameters during operations are given in this section:

4.1. Particle Accelerator Safety System (PASS) shall be functionally tested in accordance with requirements in the requirements in the BNL Radiation Control Manual.

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- 4.2. ODH ventilation fans and air inlet louvers that are signaled by the PASS shall be functionally tested annually or before the running period. Accessible fans and air inlet louvers shall be manually tested semiannually (not to exceed 8 months) or within one month of accessibility
- 4.3. STAR Highly Sensitive Smoke Detection (HSSD) systems shall undergo annual testing (not to exceed 15 months).
- 4.4. STAR Flammable Gas Detection System shall undergo annual testing (not to exceed 15 months).
- 4.5. STAR emergency exhaust fans shall undergo annual testing (not to exceed 15 months).
- 4.6. Collider fire protection shall undergo annual testing (not to exceed 15 months).
- 4.7. PHENIX Highly Sensitive Smoke Detection (HSSD) systems shall undergo annual testing (not to exceed 15 months).
- 4.8. PHENIX Flammable Gas Detection System shall undergo annual testing (not to exceed 15 months).
- 4.9. PHENIX emergency exhaust-fans shall undergo annual testing (not to exceed 15 months).
- 4.10 PHENIX High Capacity Ventilation System shall undergo annual testing (not to exceed 15 months).
- 4.11 PHENIX electronics racks interlocks in the IR shall undergo annual testing (not to exceed 15 months).
- 4.12 Area radiation monitors shall undergo annual testing (not to exceed 15 months).
- 4.13 Radiological barriers shall undergo annual visual inspection (not to exceed 15 months).
- 4.14 Rainwater barriers for activated soil shall undergo annual visual inspection (not to exceed 15 months).



## Section 5: Administrative Controls

Administrative controls necessary to ensure the operational integrity of the Collider Safety Envelope Parameters during operations are:

### 5.1. Minimum Main Control Room Staffing

- 5.1.1. C-A Main Control Room: one Operations Coordinator and one Operator shall be on duty when beam is in operation. During normal operations, one of the two must remain in the Main Control Room at all times.

Authorized Alternative: If one operator is incapacitated, the remaining operator may continue Collider operations as long as manning requirements are restored within two hours.

### 5.2. Cryogenic Control Room Staffing

- 5.2.1. Cryogenic Control Room: one Cryogenic Shift Supervisor or designee and one qualified Cryogenic Operator shall be on watch when the refrigerator is in operation. One of the two must remain in the Cryogenic Control Room at all times unless controls in the Cryogenic Control Room are relocated to the Main Control Room or unless emergency conditions require actions to be taken by all cryogenic watch standers.

Authorized Alternative: If one operator is incapacitated, the remaining operator may continue Collider operations as long as manning requirements are restored within two hours.

### 5.3. STAR and PHENIX Staffing

- 5.3.1. Watch: a qualified local watch is required when flammable gas is in the PHENIX detector in the IR.
- 5.3.2. Watch: a qualified local watch is required when flammable gas is in the STAR detector in the IR.
- 5.3.3. PHENIX Experimental Area: one Experiment Shift Leader is required for experimental operations with beam.
- 5.3.4. STAR Experimental Area: one Experiment Shift Leader is required for experimental operations with beam.

- 5.4. On-shift operations staff shall be trained and qualified on their safety, operational and emergency responsibilities. Records of training and qualification shall be maintained on the Brookhaven Training Management System, ([BTMS](#)).
- 5.5. Work planning and control systems shall comply with the requirements in the [C-A Operations Procedure Manual](#).
- 5.6. Environmental management shall comply with the requirements in with the requirements in the [C-A Operations Procedure Manual](#).
- 5.7. Experiment modification and review shall comply with the requirements in the [C-A Operations Procedure Manual](#).
- 5.7.1. Each experiment in the Collider shall be reviewed before running with beam.
- 5.8. Modifications of the Collider that are known to increase the oxygen deficiency hazards shall be reviewed and approved by the C-A Accelerator Systems Safety Review Committee.
- 5.10 Industrial hazards shall be controlled in accordance with the applicable portions of the BNL SBMS Subject Area.

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